Statement of

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"Learning from 9/11: Understanding the Collapse of the World Trade Center"

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Good afternoon Chairman Boehlert, Ranking Member Hall, and Members of the Committee. I want to thank you for this opportunity to testify on the investigation into the collapse of the World Trade Center Towers. The tragedy that the United States experienced on September 11, 2001, was unprecedented when compared with any prior accident, natural disaster, or terrorist/war attack. The collapse of the twin World Trade Center towers was the worst building disaster in human history. Engineers, emergency responders, and the nation did not anticipate, and were largely unprepared for, such a catastrophe. Among other national needs, these events highlight the following technical priorities:

- To establish the probable technical causes of the collapses and derive the lessons to be learned;
- To develop and disseminate immediate guidance and tools to assess and reduce future vulnerabilities; and
- To produce the technical basis upon which cost-effective changes to national practices and standards can be developed.

Shortly after the attacks on the World Trade Center, NIST's building and fire researchers began assisting federal and local agencies in many ways to investigate the spread of fire through the buildings and their subsequent collapse. Our researchers used previously developed models along with preliminary information from videos of the attack and other sources to simulate the spread of fire and smoke in the buildings. At the request of the Federal Emergency Management Agency (FEMA), NIST conducted a comparison and analysis of the current building and fire codes of New York City with national codes, and we contributed to the Army Corps of Engineers' study of the structural and fire damage to the Pentagon. In addition, NIST experts participated in the initial assessment of the collapse conducted by the American Society of Civil Engineers (ASCE) Coalition that comprised a Building Performance Assessment Team (BPAT) funded by FEMA. The ASCE Coalition Team also included professional members of the Society of Fire Protection Engineers (SFPE), the National Fire Protection Association (NFPA), the American Institute of Steel Construction (AISC), and the Structural Engineers Association of New York (SEAoNY). NIST is lending its expertise in structural disasters to ASCE and the Structural Engineers Association of New York (SEAoNY) to store WTC steel at its Gaithersburg, MD, headquarters for further scientific study.

However, more needs to be done. A growing number of technical experts, industry leaders, and families of victims are pressing for a broad-based Federal investigation to study the building construction, the integrity of the materials used, and all the technical conditions that combined to cause the building disaster at the World Trade Center ***[Witness would like to submit for the record, letters received supporting a federal investigation]***. NIST has begun working informally with a coalition of organizations – representing key industry, standards, codes, and professional groups – in an effort to launch a comprehensive public-private response program that includes such an investigation. NIST is also working very closely with FEMA, since an in-depth technical investigation goes well beyond the scope of the building performance assessments conducted by FEMA following major disasters. The implementation of the results of such an investigation will be critical to restore public confidence in the safety of tall buildings nationwide, enhance the safety of fire and emergency responders, and better protect people and property in the future. To cite one example, the February 4th issue of "Crain's New York Business" reports that an increasing number of tenants are leaving the Empire State Building, which is again the tallest building in New

York City, because of fears of another terrorist attack. Anecdotal evidence also suggests that building vacancy rates have doubled in Manhattan, despite the 15 million square feet of space that was lost on September 11th.

NIST has received policy approval from the Secretary of Commerce to initiate and conduct an independent and comprehensive "National Building and Fire Safety Investigation of the World Trade Center Disaster" under NIST's existing legislative authorities (15 U.S.C. 281a). NIST now is discussing within the Administration the appropriate funding for such an investigation. Among other Federal laboratories, NIST is uniquely qualified to conduct such a comprehensive investigation. The Building and Fire Research Laboratory is the foremost fire research laboratory in the United States, and through the National Earthquake Hazards Reduction Program (NEHRP) NIST is the principal agency for research and development to improve building codes and standards. NIST has extensive experience and expertise in conducting disaster investigations following structural/construction failures, fires, earthquakes, hurricanes, and tornadoes. These have included the well-known investigations into the 1981 collapse of a walkway in the Kansas City Hyatt Regency Hotel, the 1986 Dupont Plaza Hotel fire in San Juan Puerto Rico, the 1994 Northridge earthquake collapses, and the 1995 Kobe, Japan earthquake building collapses, to name just a few. In compliance with statutory requirements NIST has already consulted with local authorities in New York, including the Port Authority of NY & NJ, the Mayor's Office of Emergency Management, the New York City Department of Design and Construction, and the Fire Department of New York. These organizations have expressed support for NIST and agreed to cooperate in it's investigation.

The proposed investigation will involve world-class experts from industry, academia, and other laboratories to complement NIST's excellent in-house technical expertise. Supplementing the outstanding work done through the building performance assessment team initially assembled through FEMA, NIST would delve deeper into the factors related to the collapse. NIST would use the results of the soon to be released ASCE Coalition team's study as a valuable source of input into the investigation. The objectives of the NIST investigation would be to determine technically:

- Why and how the World Trade Center buildings collapsed following the plane impacts;
- Why the injuries were so high or low depending on location, including all technical aspects of fire protection, response, evacuation, and occupant behavior and emergency response;
- Whether or not state-of-the-art procedures and practices were used in the design, construction, operation, and maintenance of the World Trade Center Buildings; and
- Whether there are new technologies or procedures that should be employed in the future to reduce the potential risks of such a collapse.

The NIST investigation would focus primarily on World Trade Center Buildings 1 and 2 (the Twin Towers) for several reasons. First, the collapse of the Towers was the triggering event that caused much of the collateral damage to the adjacent properties. Second, many structural and fire protection design features and construction details found in the Towers are widely used in the building construction industry. Third, to study procedures and practices used to assess the safety of innovative structural systems and building designs not covered by existing building codes or prior in-use experience, as was the case for the twin towers, and whether such practices are adequate to detect and remedy inherent vulnerabilities. Fourth, to study procedures and practices

used to provide adequate structural reserve capacity to resist abnormal loads (e.g. blast, explosion, impact due to aircraft or flying debris from tornadoes, accidental fires, and faulty design and construction), especially those that can be anticipated prior to construction (such as the impact from the Boeing 707). The Twin Towers will provide the opportunity to study the effectiveness of fire protection and firefighting technologies and practices for tall buildings, including emergency mobility and egress, and communication systems. And lastly, the analytical tools used in these investigations will be experimentally verified and be widely applicable to other building types. Besides the Towers, the investigation will possibly consider examining WTC Building 7, which was adjacent to the towers and collapsed later in the day on September 11.

NIST intends to use an open and inclusive process in formulating its work plan for the investigation. This would involve the participation of technical experts from industry, academia, and other laboratories as well as liaison with federal, state, and local authorities. NIST expects to complete its investigation and issue a final report in 24 months.

The results of the proposed investigation will be extremely valuable in establishing the probable technical causes of the disaster and deriving the lessons to be learned, but it will be meaningless unless we take the knowledge gained and put it to practical use. That is why NIST, in partnership with FEMA and a number of private sector organizations, has developed a broader response program. This broader program will address critically and urgently needed improvements to national building and fire standards, codes, and practices that have begun to be recognized in recent years. The events of September 11th have brought even more focus and priority to this already important issue.

The goal of this broader program is to produce cost-effective retrofit and design measures and operational guidance for building owners and emergency responders. The program will develop and disseminate guidance and tools to assess, and produce the technical basis and recommendations for cost-effective changes to reduce vulnerabilities.

Over the course of the proposed investigation and broader program there will be a number of short-term and interim work products that will provide guidance, tools, and technical assistance to better prepare facility owners, contractors, designers, and emergency personnel for future disasters. Some of these products, based on prior NIST work, will be disseminated broadly as soon as possible. Others that need further refinement will be disseminated within a year, and the rest after the completion of the investigation. I would like to note that the President's FY 2003 budget request for NIST contains a $2 million funding increase, which will go towards this effort and related research.

Let me now give you three examples of work that would be accomplished through this broader program.

First, fire played a critical and visible role in the collapse of the WTC buildings and contributed to damage to the Pentagon buildings. Current building design practice does not consider fire as a design condition. Instead, structural fire endurance ratings are prescribed in building codes using standard tests on individual components. The current testing standards are based on work carried out at NIST in the 1920s. They do not represent real fire hazards in modern

buildings. They also do not consider the fire performance of structural connections or of the structural system as a whole, or the multiple performance demands on fire proofing materials. NIST now has the capability to simulate building fires on the computer to explain critical events and outcomes to an extent previously not possible. The proposed work will expand on this core competence in computational methods, and adapt measurement techniques and test methods to support the prediction of performance of building materials, products, structural elements, and systems up to the point of the collapse of a tall building due to fire. In short, NIST will provide the technical basis and guidance for fire safety design and retrofit of structures, the predictive tools and test methods for fire resistance determination, and the performance criteria for fireproofing materials. In addition, NIST proposes to develop guidance and retrofit technologies to enhance building egress in emergencies, practical tools and guidance to enhance the safety and effectiveness of fire and emergency responders, and improved models of occupant behavior and response to enhance evacuation and communication in emergencies.

Second, progressive collapse – which refers to the spread of failure by a chain reaction that is disproportionate to the triggering event – was also responsible for the extraordinary number of deaths in the 1995 bombing of the federal building in Oklahoma City. Yet, the United States has not developed standards, codes, and practices to assess and reduce this vulnerability. Adding to the problem for modern structures is their smaller margin of safety – and the reserve capacity to accommodate abnormal loads – due to increased efficiency in the use of building materials and refinements in analysis techniques. The work carried out at NIST in the early 1970s continues to provide the basis for the extremely limited guidance that is available in current United States standards. NIST would develop cost-effective solutions to reduce building vulnerability to progressive collapse using a multi-hazard approach that exploits synergies in resisting extreme loads from blast, impact, earthquakes, and fires.

Third, vulnerability reduction of commercial and institutional buildings and facilities. The overwhelming majority of buildings in public use today are vulnerable to terrorist attack on a number of fronts. Most lack state of the art sensing and information management systems. Few have electronic representations of the building documents or models, and standards do not exist for such representations. Most are not protected against chemical, biological, and radiological (CBR) threats. While efforts are underway to protect military buildings through Department of Defense's "immune buildings" program, there are no standards and practices for civilian buildings. NIST proposes to work with the DoD to develop guidelines and advanced technologies to reduce the vulnerability of such buildings to CBR attacks. NIST also proposes to work with industry to develop standards for building information models and information exchange, and practicable tools for helping building owners make reasoned economic choices in reducing the vulnerabilities of their buildings.

The final program element supports a construction-industry-led roadmapping effort to reflect changed priorities for development and deployment of safety and security standards, technology, and practices. It would also support the delivery and dissemination of practical guidance, tools, and technical assistance to better prepare facility owners, contractors, designers, and emergency personnel to respond to future disasters and to speed economic recovery within the industry following disasters. The effort would complement and support parallel efforts of technical organizations to improve standards, codes, and practices.

In conclusion, I believe it would be unconscionable for the U.S. to not learn from the worst-ever building disasters in human history and take aggressive remedial action to minimize future losses. As the events of September 11 demonstrated, the very stability of U.S. commerce and our economy depends upon major buildings and critical facilities that provide a key part of our Nation's physical infrastructure. Liability fears, professional pride, ignorance, and lack of leadership in the past may have often combined to impede the right kind of planning and decision-making. However, in the wake of September 11th the private sector's willingness to take necessary corrective action is extraordinarily strong. So with the envisioned Federal technical leadership and partners from the private sector, changes can be made to minimize the likelihood and consequences of future disasters. Thank you, Mr. Chairman. I would be happy to take questions from the Committee.